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BARK BEETLE HISTORY and ROOT DISEASE on the HUNGRY HORSE DISTRICT FLATHEAD NATIONAL FOREST

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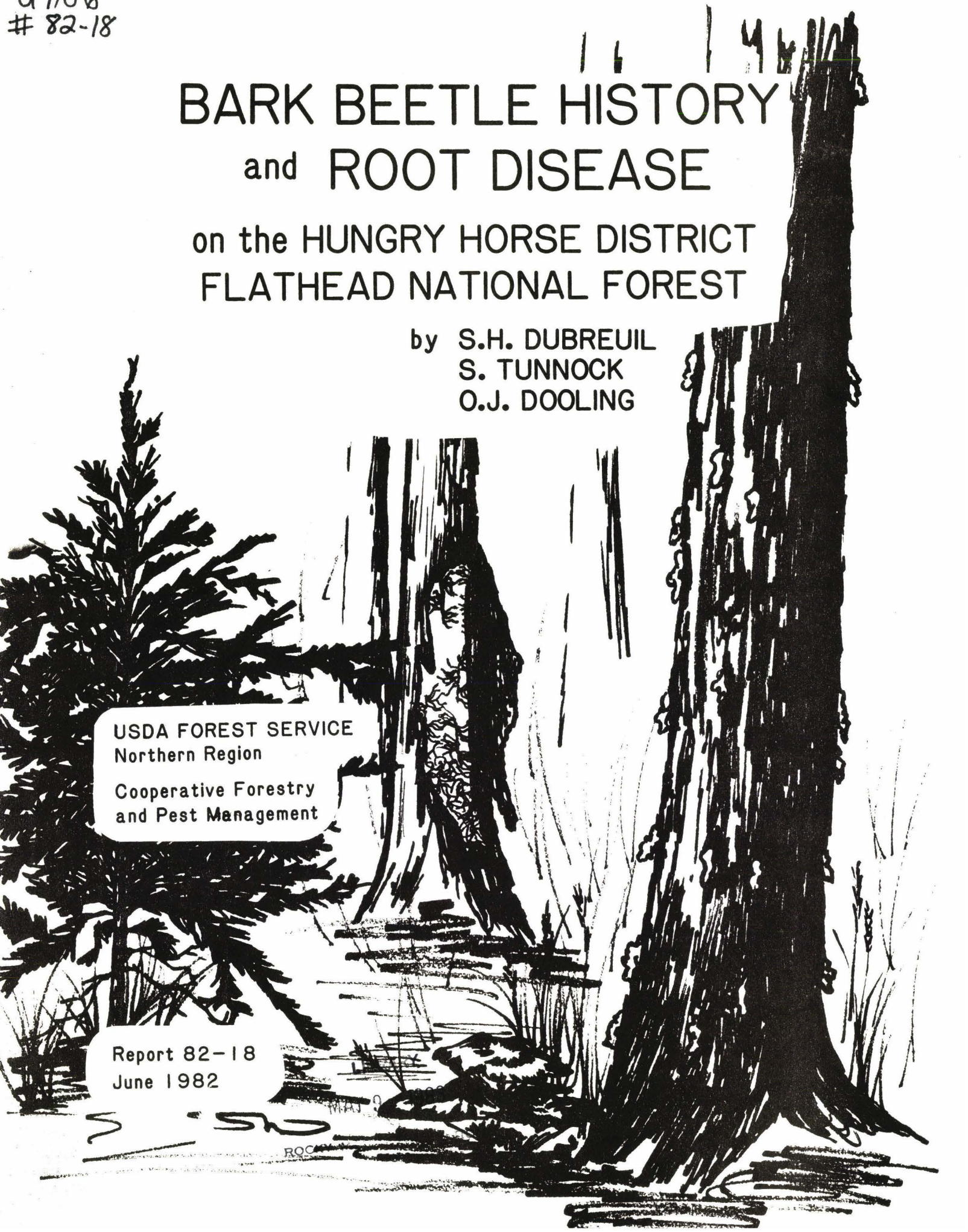

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ABSTRACT

Bark beetle mortality identified from aerial survey data, 1963-1981, is evaluated as a predictor of root disease-infested sites on the Hungry Horse District, Flathead NF. Chronic Douglas-fir beetle mortality on the Coram Experimental Forest corresponded to stands with Phaeolus schweinitzii root rot. However, Fomes annosus root rot and western balsam bark beetle caused mortality in subalpine fir which was not aerially detected. Based on bark beetle history, a map of Priority 1 areas (most likely associated with root disease) through Priority 4 (least likely) on the District is presented. Included are Douglas-fir beetle, fir engraver and western balsam bark beetle mortality. Many Priority 2 stands, those with chronic bark beetle mortality, were identified from accumulated aerial survey maps. These were concentrated in a few locations on the District. As additional sites are checked for root disease, the reliability of bark beetle history as an indicator will be further evaluated.

INTRODUCTION

Douglas-fir group mortality was noted in the Coram Experimental Forest on the Hungry Horse District, Flathead National Forest, during a 1981 aerial survey (figure 1). The trees were ground-checked by entomologists and found to have been infested by Douglas-fir beetles (Dendroctonus pseudotsugae Hopk.). Emerging adults had flown and many adjacent trees had been infested although crown symptoms were not yet visible. These and several other stands in and around the Coram Experimental Forest were examined by pathologists Sue Dubreuil and Oscar Dooling, and by Neil Hyde, District silviculturist.

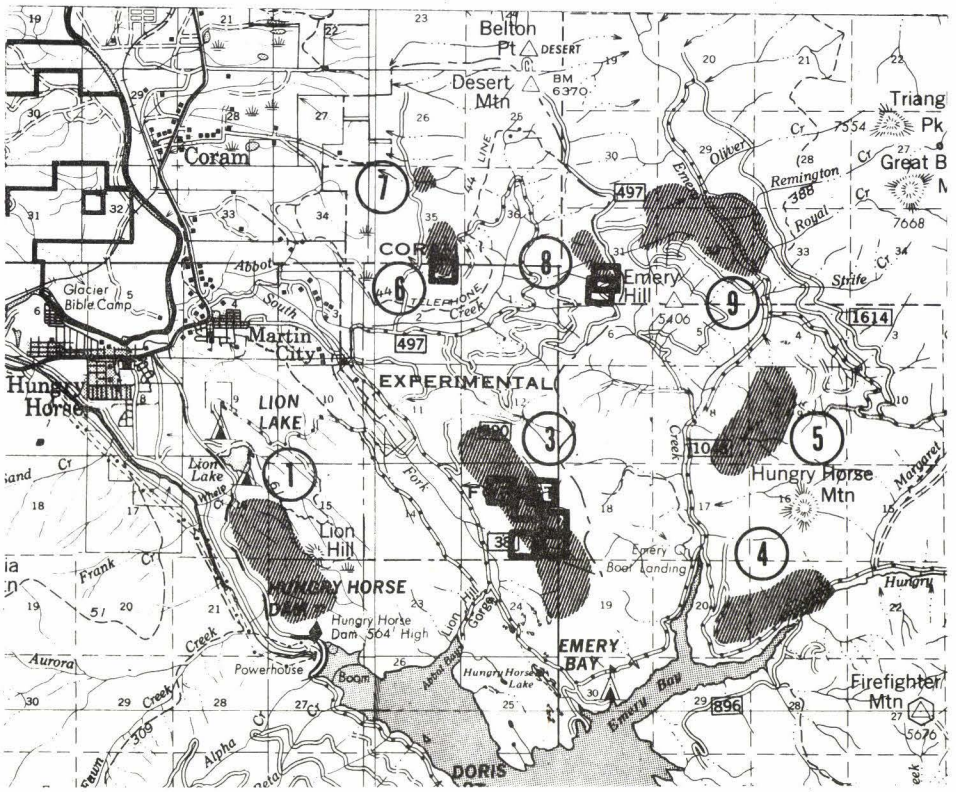


Figure 1.

Douglas-fir bark beetle group mortality from 1981 aerial survey.

Known root disease.

All these stands with aerially detected Douglas-fir beetle infestation had extensive root infection by Phaeolus schweinitzii (Fr.) Pat., the velvet top fungus (figure 1). In addition, a stand of subalpine fir (figure 1, site 9) had Fomes annosus (Fr.) Cke. root rot. Some trees had been attacked by western balsam bark beetles (Dryocoetes confusus Swaine).

Root disease lowers host vigor by reducing water uptake in affected roots. Trees with reduced vigor are more susceptible to attack by some bark beetles (Skovsgaard 1968; Felix et al. 1971; Furniss et al. 1979). Root disease is known to predispose trees to attack by bark beetles (Cobb et al. 1973; Ferrell and Smith 1976; Hertert et al. 1975). This relationship is strongest in endemic populations of bark beetles; however, Furniss et al. (1979) suggested that furtherance of Douglas-fir beetle epidemics may be facilitated in part by root disease. Two white fir stands (Abies concolor (Gord. & Glend.) Lindl.) in California had 97.1 percent and 79.3 percent of the trees attacked by fir engraver beetles (Scolytus ventralis LeConte) had F. annosus and Armillaria mellea Vahl. ex Fr. root diseases (Cobb et al. 1974). This relationship is also found in grand fir in Idaho where Phellinus (Poria) weirii (Murr.) Gilb. and A. mellea predispose trees to attack by fir engraver beetles (Hertert et al. 1975). Recently, western balsam bark beetles have been found occurring with root disease in numerous subalpine fir stands in Montana (Tunnock et al. 1982).

We have endeavored to use the association between root disease and Douglas-fir beetles in Douglas-fir, fir engraver beetles in grand fir and the possible relationship of western balsam bark beetles with root disease in subalpine fir to locate stands with root disease. Results of a preliminary examination of root disease made during a service visit to the Coram Experimental Forest vicinity are discussed and a bark beetle history map for the Coram Experimental Forest and Hungry Horse District is presented and discussed.

ROOT DISEASES ON THE CORAM EXPERIMENTAL FOREST

Preliminary Examination

PHAEOLUS SCHWEINITZII

Several Douglas-fir stands examined were infested with P. schweinitzii, a common root rot fungus (see Appendix). Numerous surface roots of several trees were exposed using a pulaski and samples were collected for culturing. Red, resinous interior of roots indicated P. schweinitzii infection (figure 2).

Figure 2.--Douglas-fir root with Phaeolus schweinitzii infection.

The severity of root rot infections, patterns of distribution of mortality, and fungus associations varied among stands. Sites are indicated on the map (figure 1).

Site 1: Scattered mortality with P. schweinitzii and A. mellea in mature and overmature Douglas-fir.

Site 3: Douglas-fir beetle group kill. Mature and pole-size Douglas-fir with severe root infections by P. schweinitzii. Live seedlings were also examined in this stand and found to have P. schweinitzii infections.

Site 4: Scattered mortality with P. schweinitzii and Douglas-fir beetle. Overmature Douglas-fir.

Site 5: Same as Area 4.

Site 6: Same as Area 4 except with some group killing with Douglas-fir beetle.

Site 8: Overmature Douglas-fir; small group kill with Douglas-fir beetle. Trees severely infected with P. schweinitzii; Inonotus (Polyporus) tomentosus (Fr. ex Fr.) Ell & Evh. (white pocket rot) also in roots of Douglas-fir.

FOMES ANNOSUS

Fomes annosus root rot (see Appendix) was associated with extensive mortality in subalpine fir on one site examined.

Site 9: Subalpine fir and Engelmann spruce were dying. Western balsam bark beetles had produced successful brood in subalpine fir and the trees subsequently died. Other trees had been attacked and contained numerous larvae. Cultures from yellow, resinous root tissue from dead trees and trees with crown symptoms confirmed the presence of F. annosus. There was no advanced decay found associated with F. annosus infections.

BARK BEETLE HISTORY ON THE CORAM EXPERIMENTAL FOREST AND HUNGRY HORSE DISTRICT

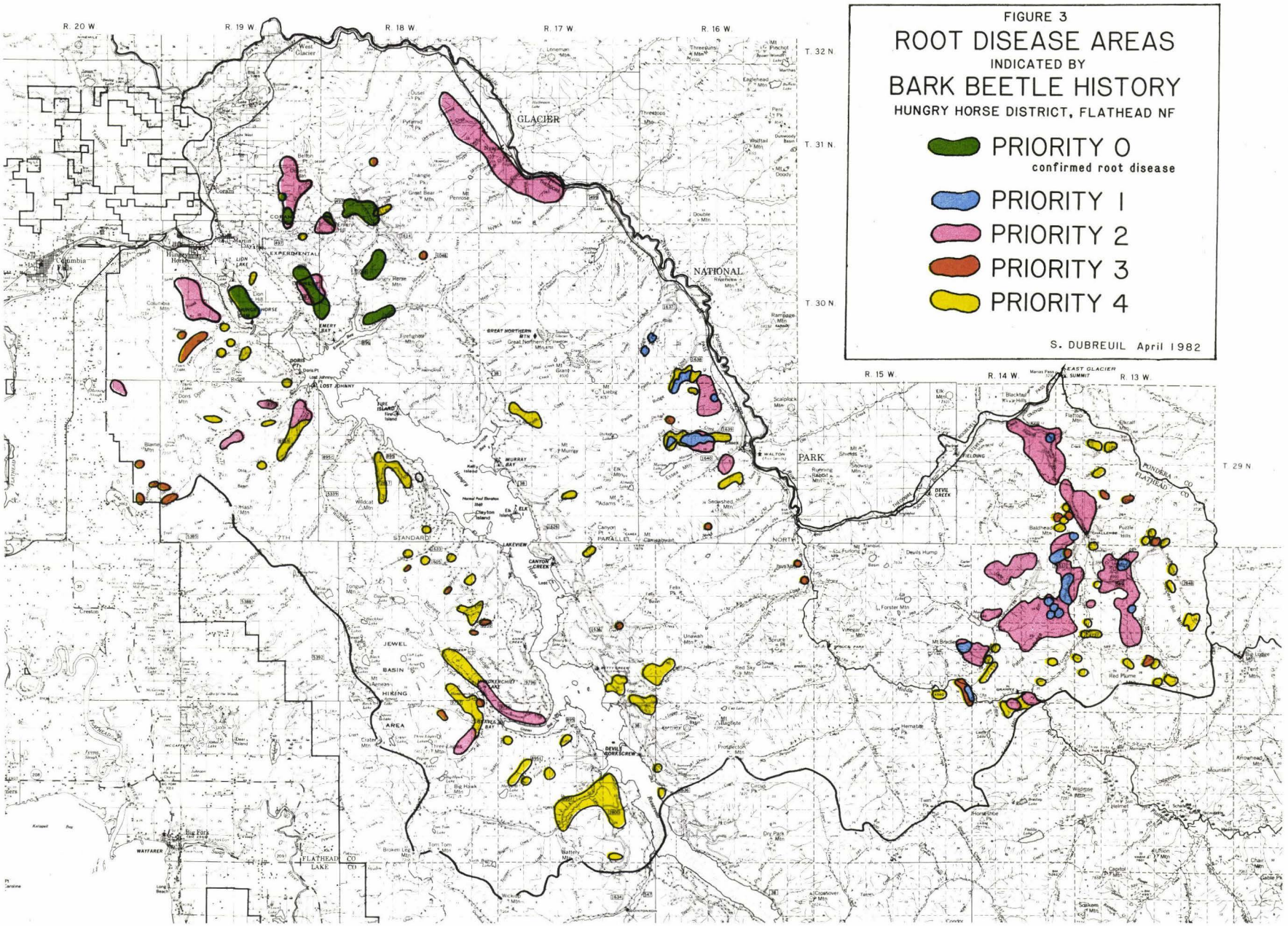
METHODS

Annual aerial surveys to detect damage have been described by Tunnock 1978. Locations and numbers of trees killed were marked on 1/2 inch = 1 mile Forest maps. Aerial survey maps of mortality due to Douglas-fir beetle, fir engraver beetle, and western balsam bark beetle from 1963-1981 were superimposed. Areas with recurring bark beetle infestation were circumscribed (figure 3). Chronic bark beetle problems thus became discernible.

Nonchronic areas in which bark beetle infestations occurred were also entered on the map. All areas were ranked according to their likeliness to indicate root disease. Priority 1 (blue) was assigned to those areas in which mortality of two or more tree species overlap. This is likely to be the strongest indicator of root disease because root disease often affects more than one species on a site while Douglas-fir beetle, fir engraver, and western balsam bark beetle tend to be more host specific. Priority 2 (red) are those areas in which mortality associated with one species of bark beetle was mapped in two or more nonoutbreak years. This would imply that a chronic, endemic bark beetle problem exists; a situation often associated with root disease (Hertert et al. 1975; Furniss et al. 1979). Priority 3 (orange) indicates beetle infestations which are less likely to be associated with root disease. They are areas in which single species bark beetle mortality was recorded only 1 year in a nonoutbreak year. However, the mortality in these locations is likely to be the result of endemic populations and may be associated with root disease.

Priority 3 is also assigned to the areas of overlap between two consecutive outbreak years. Furniss et al. (1979) suggested that root disease may be involved in this situation. Areas in which bark beetles were only recorded once, during an outbreak year, were assigned Priority 4 (yellow).

Areas in which root disease has been confirmed by ground check were assigned Priority 0 (green).



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RESULTS

Sites 3, 6, and 8 (figure 3) with aerially detected Douglas-fir beetle mortality in 1981 had chronic mortality from the beetle (Priority 2). These were the only Priority 2 areas on the Forest. Recurring Douglas-fir mortality was recorded in 1963, 1964, 1968, 1969, 1970, 1974, 1975, 1980, and 1981. Groups of dead trees ranged from 2 to 25. Douglas-fir on all three sites also had severe root disease infections. Therefore, Priority 2 designation corresponded to the presence of root disease.

Sites 1, 4, 5, 7, and 9, which had root disease, and bark beetles causing scattered mortality, were not detectable through the accumulated aerial survey maps (figure 3). The scattered pattern of mortality is more difficult to detect from the air and receives less emphasis for mapping by surveyors.

Preliminary results indicate that the bark beetle mapping system is useful for detection of some but not all root disease. Based on these results, a bark beetle history map was constructed for the entire district (figure 3).

Derived maps show areas of concentration of high priority (1 and 2) stands near Baldhead Mountain, Essex, Nyak, Graves Bay, and Hungry Horse. These stands will require ground checking to confirm the presence of root disease.

Priority 1

Large Priority 1 areas occurred in subalpine fir type near Baldhead Mountain, Mount Bradley, Patrol Ridge, Square Mountain, West Fork of Dodge Creek, and on the Middle Fork of the Flathead River near Granite USFS Campground. Priority 1 areas also occurred north of Essex Mountain and Paola Ridge and south of Tunnel Ridge. These stands had Douglas-fir and subalpine fir mortality.

Priority 2

Priority 2 stands covered greater area but were also concentrated in parts of the District. Subalpine fir mortality in the southeast part of the District was chronic over most of the area in which it was recorded. Mortality had been noted in this area since 1974 and has generally increased both in numbers and distribution since then.

Near Essex, subalpine fir mortality was recorded primarily in 1978 and Douglas-fir mortality was noted in 1963 and 1969. Douglas-fir mortality around Nyak occurred in 1963, 1968, 1969, and 1970. Mortality north of Graves Bay was noted in 1963, 1965, and 1970; and southwest of Graves Bay in 1963 and 1965. Priority 2 stands along Doris and Johnny Creeks south of Hungry Horse had Douglas-fir mortality in 1963, 1968, and 1969.

The area east of Morning Slough had group mortality in 1967 and 1975. Near Columbia Mountain, south of Hungry Horse, Douglas-fir mortality occurred in 1963, 1964, 1968, 1969, and 1970.

Mortality probably occurred in most of these areas in the intervening years in a scattered pattern less likely to be noted during aerial survey. In addition, large groups of subalpine fir mortality have been observed by aerial surveyors most years at the heads of drainages and on north slopes in the Essex vicinity, which only occasionally have been mapped due to foul weather or limited flying time.

Priority 3

A small group of Priority 3 areas east of Lake Blaine had grand fir mortality occurring in 1974 and 1975. One other Priority 3 area, on Farm Creek near Hungry Horse Dam, had numerous small groups of Douglas-fir mortality in 1969.

Priority 4

Priority 4 areas were more widely scattered but were associated with extensive mortality. Most of these areas were recorded during the Douglas-fir beetle outbreak in 1963 or in the western balsam bark beetle outbreak of 1979.

DISCUSSION

Difficulty of detection has long been a major hindrance to root disease management. Undetected root disease has been worsened through inappropriate management. Regeneration of diseased stands to highly susceptible species often results in greater damage in second rotation stands (Wallis 1976). Stumps acting as persistent reservoirs of inoculum (Greig and Pratt 1976; Blakeslee and Oak 1980), can lead to increased root disease losses in subsequent rotations (Towers 1964; Shaw and Roth 1976; Roth et al. 1980). Thinning and partial cutting are known to dramatically increase mortality rates and distribution of Fomes annosus in pine and hemlock stands (Driver and Dell 1961; Wallis and Reynolds 1970; Morrison and Johnson 1978). In some parts of the United States and in Europe, severity of F. annosus root rot corresponds directly to cutting history (Rishbeth 1957; Driver and Dell 1961; Powers and Verrall 1962; Driver and Wood 1968). Thinning and partial cutting in stands with patchy Armillaria mellea-caused mortality may result in accelerated spread and subsequent coalescence of patches into large areas of root rot mortality (Filip 1977). Windthrow may also be increased by partially cutting stands with root disease (Wallis 1976).

In addition to improving stand prescriptions, detection of root disease areas District-wide can help in planning cutting priorities. Stands identified as having high probability of root disease can be examined and scheduled for early treatment if necessary.

Bark beetle infestations may mask the effects of root disease in some stands, while in others, stand symptoms may not clearly indicate the presence of root disease. Conversely, as in the Coram Experimental Forest, particular temporal patterns of beetle mortality may aid in root disease detection.

In the future, patterns of aerially detected bark beetle mortality will be further evaluated as indicators of root disease problem areas on the Hungry Horse District. Numerous areas of each Priority designation will be ground-checked for root disease to determine their reliability as indicators.

Evidence suggests that bark beetle history mapping is an efficient method for identifying many root-diseased stands.

REFERENCES CITED

Blakeslee, G. M. and S. W. Oak.
1980. Residual naval stores stumps as reservoirs of inoculum for infection of slash pines by Phaeolus schweinitzii. Plant Disease 64: 167.

Byler, J. W., J. R. Parmeter, Jr., and R. S. Smith.
1977. A biological evaluation of the incidence and intensity of annosus root rot in the Red Lake Mountain white fir thinning area. USDA For. Serv., For. Insect and Disease Mgt., Region 5. Bio. Eval. 4 p.

Cobb, F. W., Jr., J. R. Parmeter, Jr., D. L. Wood, and R. W. Stark.
1973. Root pathogens as agents predisposing ponderosa pine and white fir to bark beetles. pp 8-15. In: Proceedings of the fourth International Conference on Fomes annosus. Ed. E. G. Kuhlman. Southeast For. Exp. Sta., USDA For. Serv., Asheville, NC. 1974.

Driver, C. H. and T. R. Dell.
1961. Observations on Fomes annosus root rot in natural stands of loblolly and shortleaf pine. Plant Dis. Reptr. 45: 352-353.

Driver, C. H. and T. R. Dell.
1961. Fomes annosus causes severe damage to thinned slash pine plantation in south Georgia. Plant Dis. Reptr. 45: 660.

Driver, C. H., and R. E. Wood.
1968. Occurrence of Fomes annosus in intensively managed young-growth western hemlock stands. Plant Dis. Reptr. 52: 370-372.

Dubreuil, S. H.
1981. Occurrence, symptoms and interactions of Phaeolus schweinitzii and associated fungi causing decay and mortality of conifers. Ph.D. disser., Univ. of Idaho. Moscow, ID. 157 p.

Ferrell, G. T. and R. S. Smith, Jr.
1976. Indicators of Fomes annosus root decay and bark beetle susceptibility in sapling white fir. For. Sci. 22(3): 365-369.

Felix, L. S., B. Uhrenholdt, and J. R. Parmeter, Jr.
1971. Association of Scolytus ventralis (Coleoptera: Scolytidae) and Phoradendron bolleanum subspecies pauciflorum on Abies concolor Can. Entomol. 103: 1697-1703.

Filip, G. M.
1977. An Armillaria epiphytotic on the Winema National Forest, Oregon. Plant Dis. Reptr. 61: 708-711.

Furniss, M. M., M. D. McGregor, M. W. Foiles, and A. D. Partridge.
1979. Chronology and characteristics of a Douglas-fir beetle outbreak in northern Idaho. USDA For. Serv., Gen. Tech. Rpt. INT-59. 19 p.

Greig., J. B. W., and J. E. Pratt.
1976. Some observations on the longevity of Fomes annosus in conifer stumps. Eur. J. For. Path. 6: 250-253.

Hertert, H. D., D. L. Miller, and A. D. Partridge.
1975. Interaction of bark beetles (Coleoptera: Scolytidae) and root rot pathogens in grand fir in northern Idaho. Can. Ent. 107: 899-904.

James, R. L. and D. J. Goheen.
1981. Conifer mortality associated with root disease and insects in Colorado. Plant Dis. 65: 506-507.

Morrison, D. J. and A. L. S. Johnson.
1978. Stump colonization and spread of Fomes annosus 5 years after thinning. Can. J. For. Res. 8: 177-180.

Powers, H. R., Jr. and A. F. Verrall.
1962. A closer look at Fomes annosus. For. Farmer 21(13): 8-9, 16-17.

Rishbeth, J.
1957. Some further observations on Fomes annosus. Fr. Forestry 30: 69-89.

Roth, L. F.; L. Rolph, and S. Cooley.
1980. Identifying infected ponderosa pine stumps to reduce costs of controlling Armillaria root rot. J. of For. 78(3) 145-148.

Shaw, C. G., III, and L. F. Roth.
1976. Persistence and distribution of an Armillaria mellea clone in a ponderosa pine forest. Phyto. 66: 1210-1213.

Skovsgaard, J.
1968. Douglas-fir beetle in British Columbia. For. Pest Leafl. 14, For. Insect and Dis. Survey. 5 p.

Tegethoff, A. C.
1973. Known distribtuion of Fomes annosus in the Intermountain Region. Plant Dis. Reptr. 57: 407-410.

Towers, B.
1964. Root-contact infection by Fomes annosus in a thinned loblolly pine plantation. Plant Dis. Reptr. 48: 767-769.

Tunnock, S.
1978. Guidelines for detection surveys of forest pest in the Northern Region. USDA For. Serv., Northern Region, Forest Pest Mgt., unnumbered report. May 1978. 18 p.

Tunnock. S., S. H. Dubreuil, and S. Kohler.
1982. Forest insect and disease conditions in Montana 1981. USDA For. Serv., Northern Region, Cooperative Forest and Pest Mgt., Report 82-2.

Wallis, G. W. and G. Reynolds.
1970. Fomes annosus root and butt rot: a threat in managed stands in coastal British Columbia. For. Chron. 46: 221-224.

Wallis, G. W.
1976. Phellinus (Poria) weirii root rot detection and management proposals in Douglas-fir stands. Env. Can., For. Serv., For. Tech. Rpt. 12. 16 p.

Williams, R. E.
1971. The root rot problem in the Northern Region. USDA For. Serv., Northern Region Insect and Disease Rpt. 71-43. 7 p.

APPENDIX

Phaeolus schweinitzii Life History

Phaeolus schweinitzii is a root pathogen causing death of feeder roots, decay of support root heartwood and root gall formation. Brown, cubical butt rot of stem heartwood occurs in severely diseased trees or those in which infection occurred through basal wounds. The fungus invades small roots and grows upward through the inner wood toward the root crown. There is probably little spread of the fungus from tree to tree through root contacts. Seedlings are infected and occasionally may be killed. However, it is generally only in mature trees that damage causes a measurable decline in tree vigor or increase in proneness to windthrow. Deterioration of root systems by P. schweinitzii is very slow with the result that expression of symptoms is exceedingly gradual. Considerable deterioration of the root system may have occurred in trees showing indistinct or no crown symptoms. Crowns of severely affected trees become thin and chlorotic. Trees in this condition often sustain lethal attacks by A. mellea or Douglas-fir beetles (Dubreuil 1981).

Areas of P. schweinitzii infestation are extensive, perhaps occurring throughout one or more adjacent stands. They are often pockmarked with distinct mortality centers, usually also associated with A. mellea or Douglas-fir beetle group kills. Scattered mortality, especially of dominant trees, and individual windthrown or windbroke trees also are typical of P. schweinitizii-infected stands. Sporophores are occasionally found on or near the base of live, severely infected trees, cut stumps, or windbroke trees. They are brown on top and green, becoming brown with age, on the underside. They are spongy when moist and brittle when dry. Several "caps" are generally produced from one stem producing a mass which may be 1-2 feet in diameter.

Fomes annosus Life History

The ecology of F. annosus is not well understood in the Northern Region. More is known of its habits in the southeastern and southwestern States and in Europe where it causes major root disease problems in pines. Extensive butt rot and root rot of white fir in California (Byler et al. 1977; Cobb et al. 1973) and Colorado (James and Goheen 1981) resulted from F. annosus infections. Mortality in these stands was also associated with fir engraver beetles. Many live white fir also had F. annosus present in stem and roots with little or no decay.

Subalpine fir in the Northern Region has little evidence of butt rot. However, root rot caused by F. annosus with attacks by western balsam bark beetles may have caused large pockets of mortality and frequent scattered tree mortality in Montana (Tunnock et al. 1982). Fomes annosus infection was previously reported in subalpine fir in the Northern Region (Williams 1971) and in the nearby Intermountain Region (Tegethoff 1973).